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| **20 Lesson Unit Plan** | **Grade 11 Physics – Waves and Sound**  Completed by Paul Plazek | | **SPH3U** |
| **Unit Rationale**: This unit will cover the following overall Ministry expectations for the unit on Waves and Sound:  E1. analyse how mechanical waves and sound affect technology, structures, society, and the environment, and assess ways of reducing their negative effects;  E2. investigate, in qualitative and quantitative terms, the properties of mechanical waves and sound,  and solve related problems;  E3. demonstrate an understanding of the properties of mechanical waves and sound and of the principles  underlying their production, transmission, interaction, and reception.  The unit plan begins with a general introduction to the concept of waves and then moves into types of waves and their physical properties including: speed, wavelength, frequency, interaction, production, transmission and reception. The concept of sound as a wave is then examined. A substantial amount of time is spent on applying what has been learned to real life problems and to examining and understanding how waves interact in nature. Demonstrations and labs are used throughout this unit plan to clarify and solidify concepts and learning. In the latter portion of the unit plan the negative effects of waves are examined as well as how we can utilize the properties of waves for our benefit. Assessment is done throughout and includes a quiz after 6 lessons, a final unit test, and a culminating task near the end of the unit. | | | |
| **General Notes**: Specific textbook work and readings can accompany this unit where applicable and provide more background information for concepts. Gizmos ([www.explorelearning.com](http://www.explorelearning.com)) is a subscription site that does have a 30 day free trial period. | | | |
| **Achievement Chart Criteria** | | | |
| KU | Knowledge and Understanding | | |
| TI | Thinking and Investigation | | |
| C | Communication | | |
| A | Application | | |
| **Skills Being Developed** | | | |
| RSTSE | Relating Science to Technology, Society, and the Environment | | |
| IP | Initiating and Planning | | |
| PR | Performing and Recording | | |
| AI | Analysing and Interpreting | | |
| COM | Communicating | | |
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| **Lesson (Title and Topic)** | **Code** | **Lesson Strategy and Assessment** | **Evaluation** |
| 1. Introduction to waves and sound – what is a wave? Lab introduction and safety review. | E3.1  E2.1  E2.2 | Review of the lab and safety issues.  Review the scientific method on a worksheet.  Get the students to answer the question: What is a wave? Hand in the worksheet. Have the students line up around the classroom and do the “wave”. Discuss what occurs. Repeat the demo but use a long rope and 2 volunteers. Review “medium”, “propagation”, and energy transfer.  **Skills**: COM, AI  **ELL**: Have review material pre-printed or downloadable. | Worksheet – Includes students’ ideas on the scientific method and what they thought a wave was. (Assessment for learning - KU) |
| 2. Waves in nature: transverse and longitudinal (an intro) | E2.1  E3.1 | Brainstorming session on waves found in nature (Mind Map on SMART Board). Note how long it takes the class to determine that there are 2 kinds of common waves – transverse and longitudinal. Give examples of both and discuss. Students should copy Mind Map into their notes.  Have students chose their lab partners and review proper use of the computers for virtual labs. Have the students log onto Gizmos and give an introductory tutorial.  **Skills**: RSTSE, AI, PR, COM  **IEP, ELL**: Provide download of today’s Mind Map | Anecdotal notes and observations.  (Assessment for and as learning – KA, TI, C). |
| 3.Properties of Transverse waves: Amplitude, Wavelength, Period, Cycle, Frequency | E2.1  E2.2  E2.4 | Long slinky demo with 1 point marked off to demonstrate wave (or energy) forward motion and lack of material forward motion.  Instruction – properties of transverse waves: **Amplitude**, **Wavelength**, **Period**, **Cycle**, **Frequency**. Introduce relationship between wave speed, frequency, and wavelength (qualitatively only).  **Skills**: PR, AI  **IEP**: Provide extra support/time/questions to ensure understanding | Whole class questions and an exit card on today’s learning.  (Assessment as and for learning – KU, TI) |
| 4.Properties of Longitudinal waves: wavelength, period, cycle, frequency, compression, rarefaction | E2.1  E2.2  E2.4  E3.1 | Demos to introduce transverse waves (use a Slinky and Gizmos – “Longitudinal Waves”).  Instruction – properties of transverse waves: **Wavelength, Period, Cycle, Frequency, Compression, Rarefaction**.  Introduce wave formula. Finish with a short worksheet containing questions that require use of the wave formula.  **Skills**: RSTSE, PR, AI, COM  **IEP**: Provide extra support/time/questions to ensure understanding | Anecdotal notes and observations.  Worksheet handed in at the end of class.  (Assessment as and for learning – KU, TI, C, A) |
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| 5.Transmission of waves: Determining the Speed of Waves in different Medium including along a string. | E3.5  E2.3 | Brainstorm on how the particle theory of matter helps explain the speed difference of waves in different mediums.  In pairs have the students discuss how they would determine the speed of a wave in a solid object of unknown composition.  Have each pair join another pair. Each team of four chooses the best method of determining the speed. Hand in one sheet with the solution on it per team of 4.  Briefly introduce the experiment that will take place in class #12 to determine the speed of sound in air using “resonance”.  Speed of waves on a string: New concept→string length = ½ \* λ (question sheet)  **Skills:** RSTSE, IP, AI, COM  **IEP, ELL**: Encourage cooperative work with partners. | Solution sheet of how to determine the speed of a wave.  String question sheet  (Assessment as learning – TI, C, A) |
| 6. Sound as a wave. The speed of sound in different mediums. | E3.5  E2.3 | Class discussion on whether sound is a wave. Can we test our hypothesis? Mechanical waves (not electromagnetic) cannot travel in a vacuum. Perform the bell jar experiment to illustrate that sound is a form of mechanical wave and will not travel in a vacuum. Demo to illustrate a sound wave: Air gun vs. long slinky. Record the results and use Think –Pair-Share to discuss.  More practice questions using “wave speed = λ \* f”  **Skills**: PR, AI | An exit card is due on what has been learned today plus check notes on demos.  (Assessment as learning – KU, TI) |
| 7.Quiz of lessons 1-6 |  | Types of waves (and examples in nature), properties, basic use of wave formula, understanding of the scientific method.  **Skills**: RSTSE, AI, COM  **IEP**: Extended time, modified questions (not modified curriculum or expectations)  **ELL**: Ensure diagrams are easily read and questions use simplest language possible to accomplish the assessment effectively. | Quiz (Assessment of learning – KU, TI, C, A) |
| 8.Use and transmission of waves and sound in nature | E3.6  E3.1 | 4 corners – Dolphin, bat, dog, elephants. Have the class go to their favourite animal and as a group come up with the ways in which that animal utilizes sound. Use terms like frequency, wavelength, transverse, longitudinal, wave speed, etc. Each group will put on a short “Hinterland Who’s Who” about the animal in front of the class.  Review any misconceptions.  <http://www.hww.ca/index_e.asp> Go to this website to hear the classic HWW song.  **Skills**: IP, COM, RSTSE  **IEP, ELL**: Prepare instructional handouts and allow for extra questions. Encourage cooperative work with partners. | Hinterland Who’s Who Presentation (Assessment for, as, and of learning – KU, TI, C, A) |
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| 9.Interaction of waves: Doppler Effect | E2.1  E2.5 | Gizmos Lab. Students will complete the lab on the Doppler effect which will include hypothesis, set-up, experiment, observations, and conclusions. Lab partners will measure the frequency of approaching and receding objects at varying speeds and collect and record the data. Key question: What happens to the frequency as the source advances and recedes and why?  **Skills**: RSTSE, IP, PR, AI, COM  **IEP, ELL:** Prepare instructional handouts. Encourage cooperative work with partners. | Lab rubric provided and Lab handed in either today or next class. (Assessment as and of learning – KU, TI, C, A) |
| 10.Interaction of waves: The Observed Frequency Formula for moving source and/or receiver | E2.1  E2.4 | Review the Gizmo Lab on the Doppler effect. Brainstorm how the frequency of the approaching sound could be determined. Derive the Observed Frequency formula using their thoughts and teacher background knowledge: Fobs=Fs[(V+/- VR)÷(V-/+Vs)] {Note: some texts may not have this but online sources do}. Provide several questions for them to practise on. Encourage group work on solutions. (we will revisit this formula in lesson 13)  **Skills:** RSTSE, AI, COM  **Ell, IEP**: Ensure notes are online or handed out as well. | Practise questions due next class. (Assessment as learning – C, A). |
| 11.Interaction of waves: Resonance (Introduction), Standing Waves | E3.2  E3.3  E2.6  E3.4  E2.1 | Introduction to resonance. Simple example – swings. Perform the vibrating metal rod demo (very loud and fun). Have the class draw and label what is happening with the rod.  Show this demo:  <http://www.walter-fendt.de/ph14e/stwaverefl.htm>  to illustrate how resonance in waves causes standing transverse waves. Have the students draw and label what they see. Connect that image with the Gizmo on “Longitudinal Waves” to show that **resonance** and **standing waves** with sound in a tube (longitudinal) are the same phenomenon as **resonance** and **standing waves** in transverse forms.  Use the terms **constructive** and **destructive interference** to describe the above phenomena.  **Skills**: RSTSE, PR, AI, COM  **Ell, IEP**: Ensure notes are online or handed out as well. | Students will provide an Exit Card answering several questions on key concepts of the class.  Anecdotal notes and observations especially the diagrams of the students.  (Assessment as and for learning – KU, TI) |
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| 12. Lab: Speed of sound using resonance and standing waves. | E2.7 | Speed of sound in air experiment. Students will perform a sound experiment (with partners) with tubes, tuning forks, and glasses of water to determine the speed of sound in air using the concepts of resonance and standing waves. See website below for reference:  (<http://www.lhup.edu/~dsimanek/scenario/labman2/soundvel.htm>)  **Skills**: RSTSE, IP, PR, AI, COM  **IEP, ELL**: Prepare instructional handouts. Encourage cooperative work with partners. | Lab rubric provided and Lab sheets handed in. (Assessment of and as learning – KU, C, A). |
| 13.Negative effects of waves and sound and more problem solving. | E1.2  E2.2  E2.4 | Brainstorm on the possible negative effects of waves and sound. Video: <http://www.youtube.com/watch?v=3mclp9QmCGs> Show this video of the collapse of the Tacoma Narrows Bridge (very spectacular). Questions to answer in teams – How could this have been stopped? How do we stop unwanted resonance based on what you know? List other examples of the negative impact of waves and sound (e.g. pollution) and discuss.  Review the use of Fobs*=Fs[(V+/- VR)÷(V-/+Vs)]* . Give out practice problems and have the students work in groups of 3 to solve.  **Skills**: RSTSE, AI, COM  **IEP, ELL**: Thoroughly discuss beforehand what the students are about to see in the video and why. Make a strong relation to the curriculum. Ensure at least one “level 3+ or 4” student in each group. | Observation and anecdotal notes of answers.  (Assessment as learning – TI, C, A). |
| 14. Culminating task explanation and work time. | E1.1 | Culminating task review and explanation. Answer questions and concerns. Give out timelines and form groups of 3. Groups can work on task for the rest of the period.  **Skills**: RSTSE, IP  **IEP, ELL**: Encourage cooperative work with partners. | Observation. (Assessment as learning - C) |
| 15.Interaction of waves and sound: Beat | E3.3 | Students will complete the Gizmos on “Sine waves and Beat”.  Inquiry learning to determine why beat happens what happens when it does and how we can use this phenomenon to our advantage. (E.g. musicians to tune instruments. I would bring my guitar in and demonstrate.)  **Skills**: RSTSE, IP, PR, AI, COM  **IEP, ELL**: Prepare instructional handouts. Encourage cooperative work with partners. | Lab rubric provided and Lab handed in. (Assessment of and as learning – KU, TI, C, A) |
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| 16. Draft of culminating task due at the end of class. |  | Allow some time to work on the culminating task.  Video: Rubin’s Tube <http://www.youtube.com/watch?v=gpCquUWqaYw&feature=related>  Illustrates resonance in a tube. Have the students discuss what they think is going on.  **Skills**: RSTSE, AI, COM  **IEP, ELL**: Thoroughly discuss beforehand what the students are about to see in the video and why. Make a strong relation to the curriculum. Encourage cooperative work with partners for culminating task. | Anecdotal notes and observations during work time and discussions.  (Assessment as and for learning – C, A) |
| 17.Solving problems with waves | E2.4 | Review more complex wave problems using the wave speed formula (S=λ x F) and the observed frequency formula Fobs*=Fs[(V+/- VR)÷(V-/+Vs)]* . Review problems and brainstorm different variations of questions possible. Complete question sheet.  **Skills**: RSTSE, AI, COM  **Ell, IEP**: Ensure notes are online or handed out as well. | Question sheet to be peer reviewed. (Assessment as learning – KU, C, A) |
| 18.Effect of waves on Technology, Society and the Environment | E1.1  E1.2 | How is the design and structure of places, objects and technological devices affected by the properties of waves including sound waves?  (Acoustic nature of music halls, the shape and length of instruments, communication devices, recording studios, etc.) Have the class break into groups of 4. Each group will present their findings on how the designs of their 2 items are affected by the properties of waves. Presentations due in the second half of class.  **Skills**: RSTSE, IP, AI, COM  **IEP, ELL**: Prepare instructional handouts. Encourage cooperative work with partners. | Observation and anecdotal notes on group work, plus presentation grading. (Assessment as and of learning – KU, C, TI, A) |
| 19. Review and culminating task due today. |  | Culminating task due today.  Review unit concepts on waves and sound.  **Skills**: RSTSE, AI, COM | Culminating tasks (Assessment of and as learning – KU, TI, C, A) |
| 20. End of unit test |  | Unit Test (all topics covered in this unit including days 1-18)  **Skills**: RSTSE, AI, COM  **IEP**: Extended time, modified questions (not modified curriculum or expectations)  **ELL**: Ensure diagrams are easily read and questions use simplest language possible to accomplish the assessment effectively. | Unit test (Assessment of learning – KU, TI, C, A) |